

[3] shunt-shunt F.B

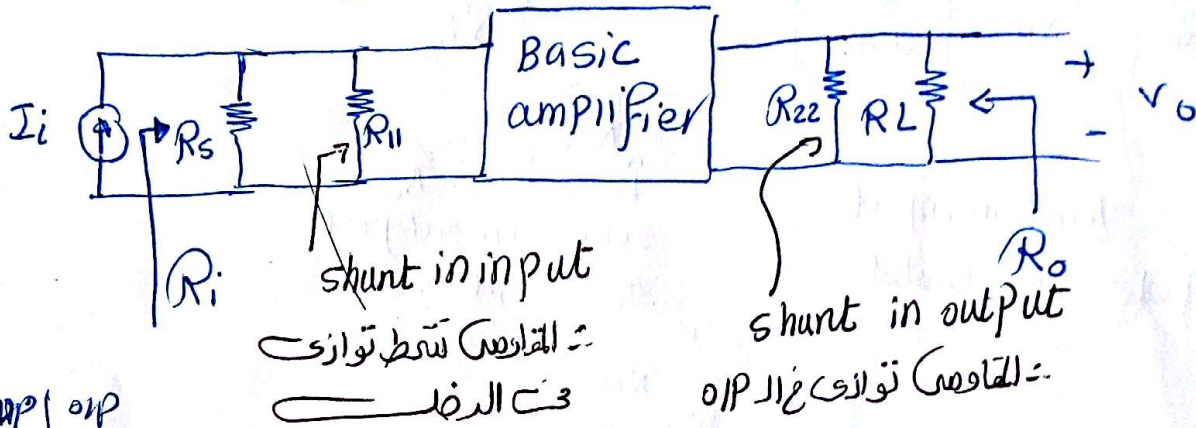
Sec (3)
Feedback

↓
ده معناه
ف الدخول

↓
ده معناه
جهد الخرج

تيار فكا
iip

جهد
ال xpo



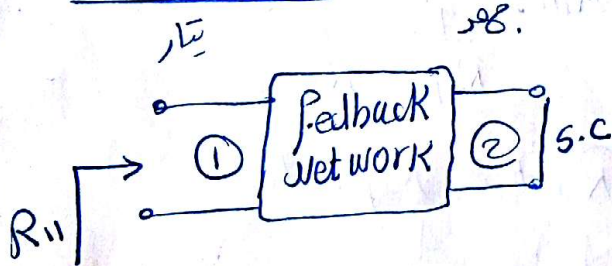
shunt in input
المقاومة تسطر توازي
ف الدخول

shunt in output
المقاومة توازي ف ال xpo

ال اتيقن دول لسيت وجود
ال feedback

	iip	xpo
V	o.c	s.c
I	s.c	o.c

* To find R_{11}



* To find R_{22}



* To find β



$$\beta = \frac{V_f}{V_o}$$

جهد V_o يطغ تيار I_f

$$\beta = \frac{I_f}{V_o} \Rightarrow \text{Trans Conductance}$$

معلوب المقادير

* in shunt-shunt

$$R_{in} = \frac{1}{\frac{1}{R_i} - \frac{1}{R_s}}$$

توازي

$$R_{out} = \frac{1}{\frac{1}{R_o} - \frac{1}{R_L}}$$

توازي

• R_i & R_o

$$(1+AB) R_i$$

$$\text{or } \frac{R_i}{(1+AB)}$$

R_o & R_i
تزداد أو تقل

$$1+AB$$

نتيجة ال F.B

• R_i & R_o

دي بتعيط من ال model بتاع ال دياره

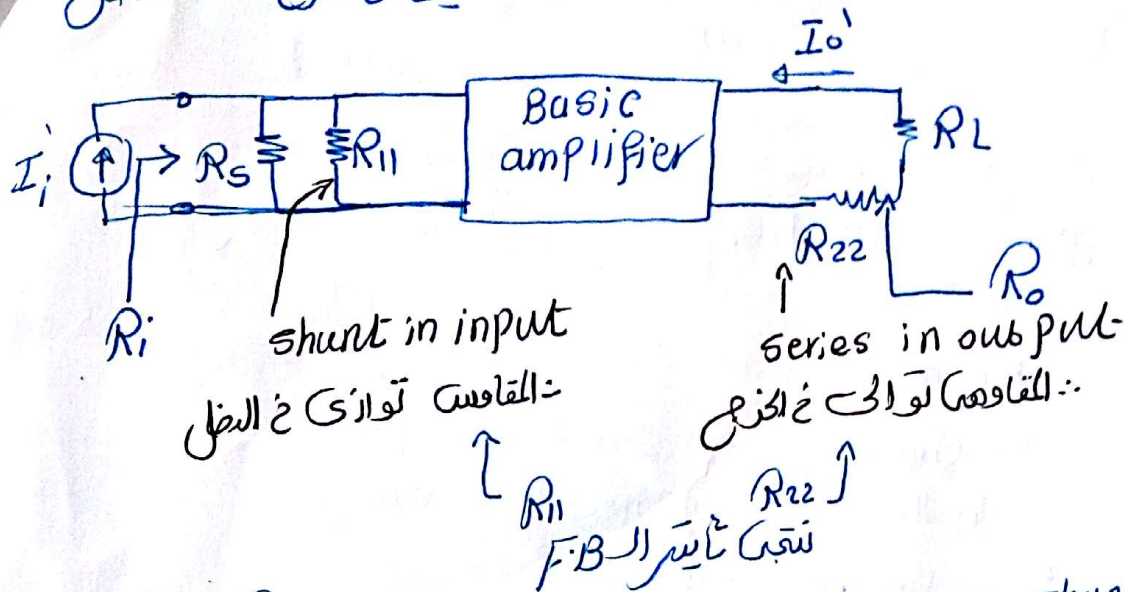
• A

افادته
اياد مقادير
ال xpo
لا ياد
B

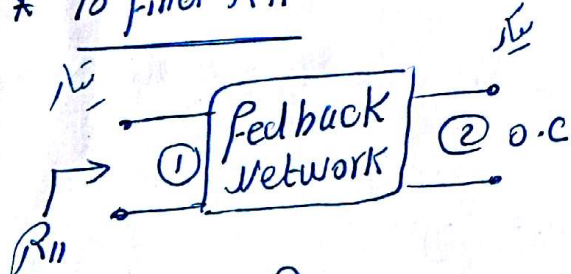
shunt-series F.B

ده معناه تيار
توازي في الدخل
ده معناه
تسلسلي في الخارج

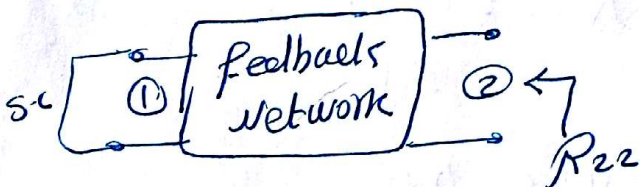
تيار في الخرج → تيار في الدخل



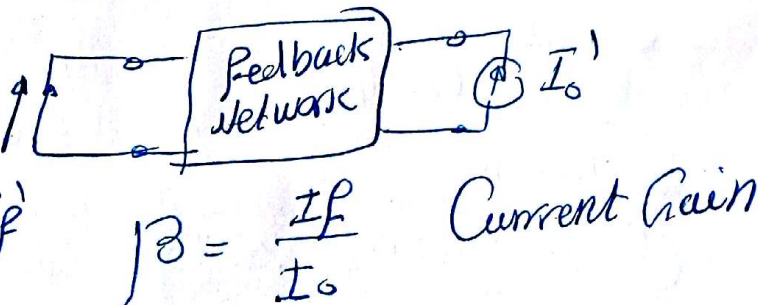
* To find R_{11}



* To find R_{22}



* To find β



* in shunt-series F.B

$$R_{in} = \frac{1}{\frac{1}{R_{if}} - \frac{1}{R_s}}$$

$$R_{out} = R_o \parallel R_L$$

$$A_v = \frac{A}{1+A\beta}$$

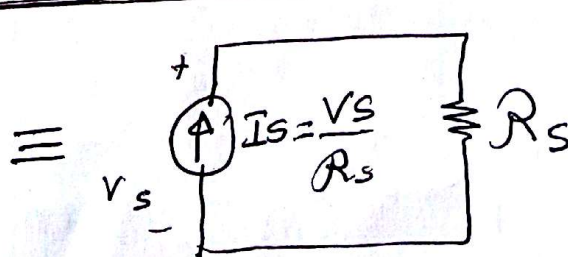
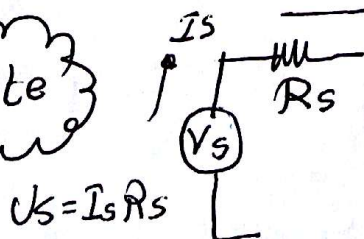
R_{if} & R_{of}

$$R_{if} = \frac{R_i \cdot (1+A\beta)}{1+A\beta} \quad R_{of} = \frac{R_o \cdot (1+A\beta)}{1+A\beta}$$

$$A \gg R_i, R_o$$

يعتبر اي اهم من ال model

Note



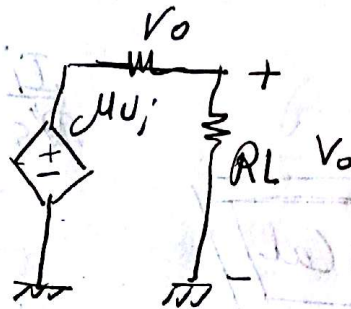
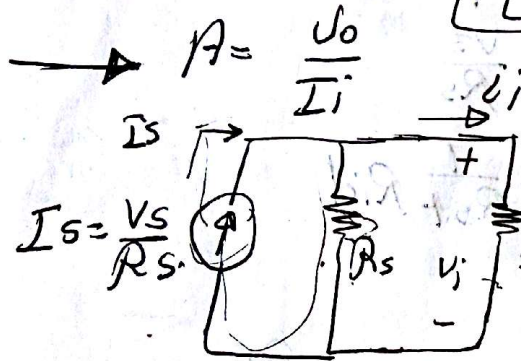
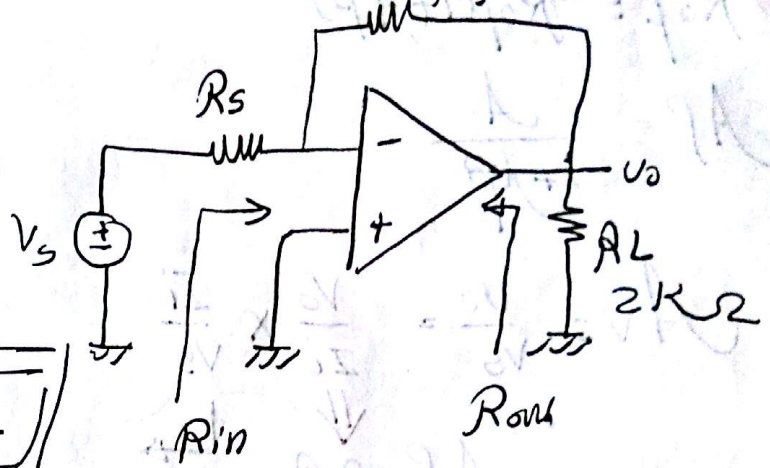
مصدر جهد توازي مع مقاوم
يادي
مصدر تيار توازي
مع نفس المقاوم

Example : shunt-shunt type find Gain, R_{in} , R_{out}
 IF $\mu = 10^4$ $R_{id} = 100k$ $r_o = 1k\Omega$ $R_F = 1M\Omega$
 For ideal - practical

Solution

shunt-shunt
 $\downarrow I_i$ $\downarrow V_o$

ideal



Note

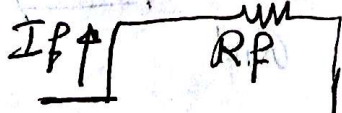
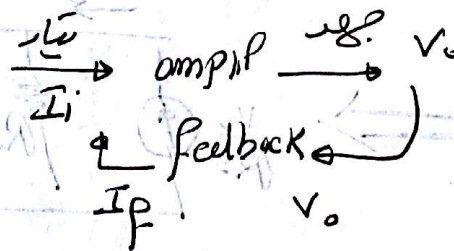
For ideal
 Neglect R_{in} , R_{out}
 For practical
 put R_{in} , R_{out}

$$V_o = \mu V_i \times \frac{R_L}{R_L + r_o} \quad \& \quad V_i = I_i R_{id}$$

$$V_o = \mu I_i R_{id} \frac{R_L}{R_L + r_o}$$

$$A = \frac{V_o}{I_i} = \frac{\mu R_L R_{id}}{R_L + r_o}$$

$$\beta = \frac{I_F}{V_o}$$

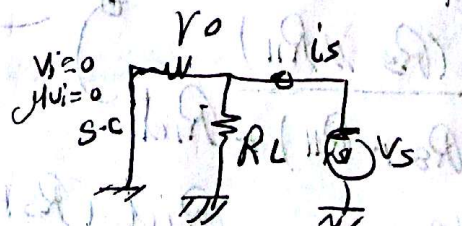


$$\beta = \frac{I_F}{V_o} = \frac{1}{R_F}$$

$$R_i = R_s \parallel R_{id}$$

$$R_o \parallel \text{put } V_s = 0 \&$$

$$R_o = R_L \parallel r_o$$



$$R_{if} = R_i / (1 + A\beta)$$

$$* R_{of} = R_o / (1 + A\beta)$$

$$* A_f = \frac{A}{1 + A\beta}$$

$$A_v = \frac{V_o}{V_s} = \frac{V_o}{I_i} \times \frac{I_i}{V_s}$$

$\downarrow$ $\downarrow$
 A_f $\frac{I_i}{V_s}$

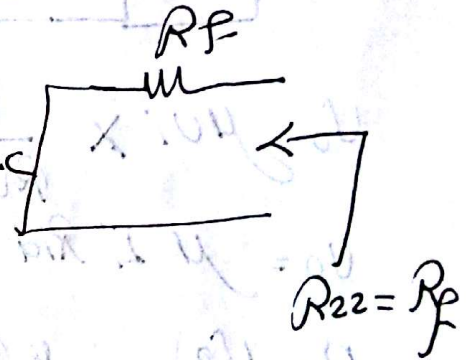
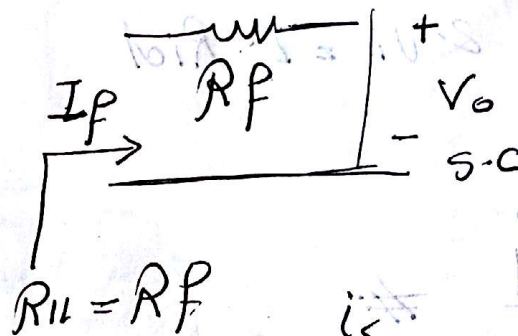
$$I_i = I_s \times \frac{R_s}{R_s + R_{id}}$$

$\uparrow$
 $\frac{V_s}{R_s}$

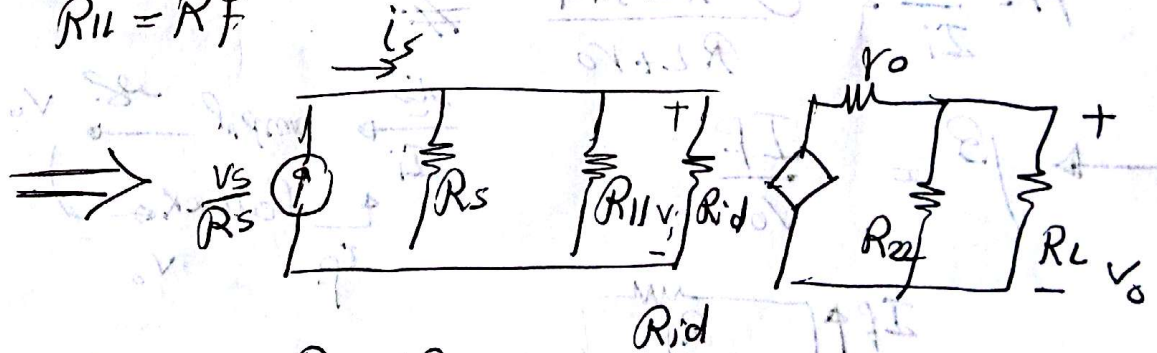
$$\frac{I_i}{V_s} = \frac{1}{R_s + R_{id}}$$

practical

R_{11}, R_{22}



model
 R_{11}, R_{22}



$$A = \frac{V_o}{I_s} \Rightarrow V_o = \mu V_i \frac{R_{22} \parallel R_L}{(R_{22} \parallel R_L) + r_o}$$

$$V_i = I_i R_{id}$$

$$I_i = I_s \frac{(R_s \parallel R_{11})}{(R_s + R_{11}) + R_{id}}$$

$$A = \frac{V_o}{V_s} = \frac{R_{id} (R_s + R_{11})}{(R_s \parallel R_{11}) + R_{id}} * \frac{(R_{22} \parallel R_L)}{(R_{22} \parallel R_L) + r_o}$$

$$\beta = \frac{1}{R_F}$$

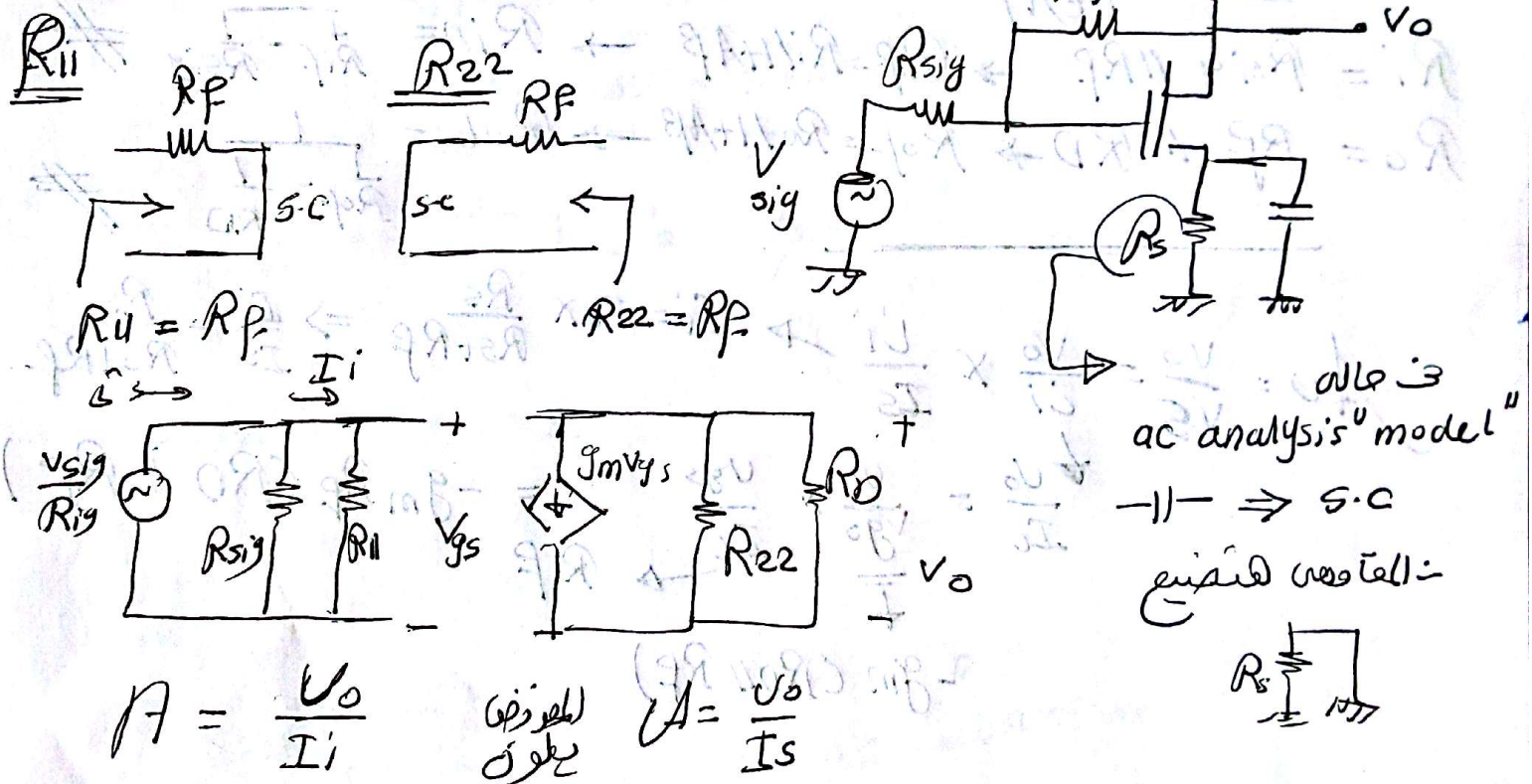
$$R_i = R_s \parallel R_{11} \parallel R_{id} \rightarrow R_{if} = R_i / (1 + A\beta) \rightarrow R_{in} = \frac{1}{\frac{1}{R_{if}} + \frac{1}{R_L}}$$

$$R_o = R_L \parallel R_{22} \parallel R_o \rightarrow R_{of} = R_o / (1 + A\beta) \rightarrow R_{out} = \frac{1}{\frac{1}{R_{of}} + \frac{1}{R_L}}$$

Example [2]: for shunt-shunt F.B

Find $A, \beta, A_f, R_{in}, R_{out}, A_v = \frac{V_o}{V_s}$

For practical



$$A = \frac{V_o}{I_i}$$

$$\beta = \frac{V_o}{I_s}$$

$$V_o = -g_m V_{gs} \times (R_{22} \parallel R_D)$$

$$V_{gs} = I_i R_F$$

$$I_i = I_s \times \frac{R_{sig}}{R_{sig} + R_{11}}$$

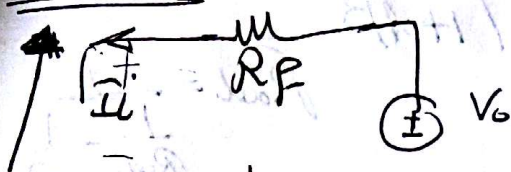
$$\therefore V_{gs} = I_s \frac{R_F R_{sig}}{R_{sig} + R_F} \approx I_s R_{sig}$$

$$V_o = -g_m I_s R_{sig} (R_{22} \parallel R_L)$$

$$A = \frac{V_o}{I_s} = -g_m R_{sig} \times (R_{22} \parallel R_L)$$

$$A = \frac{V_o}{I_i} = \frac{V_o}{V_{gs}} \times \frac{V_{gs}}{I_i}$$

* For β



$$\beta = -\frac{1}{R_F}$$

$$A_F = \frac{V_o}{I_s} = \frac{CA}{1+A\beta} \quad \#$$

$$R_i = R_{sig} \parallel R_F \rightarrow R_{if} = R_i / (1+A\beta) \rightarrow R_{in} = \frac{1}{\frac{1}{R_{if}} - \frac{1}{R_{sig}}} \quad \#$$

$$R_o = R_F \parallel R_D \rightarrow R_{of} = R_o / (1+A\beta) \rightarrow R_{out} = \frac{1}{\frac{1}{R_{of}} - \frac{1}{R_D}} \quad \#$$

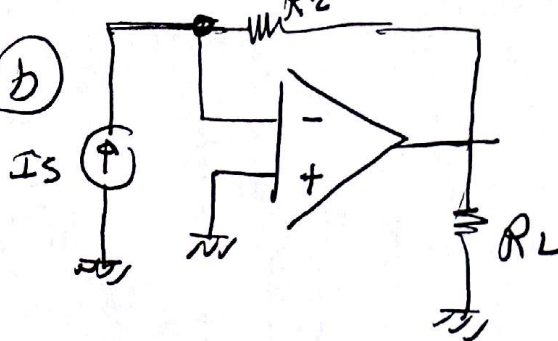
$$A_v = \frac{V_o}{V_{gs}} = \frac{V_o}{I_i} \times \frac{I_i}{I_s} \rightarrow I_i = I_s \times \frac{R_s}{R_s + R_F} \Rightarrow \frac{I_i}{I_s} = \frac{R_s}{R_s + R_F}$$

$$\frac{V_o}{I_i} = \frac{V_o}{V_{gs}} \times \frac{V_{gs}}{I_i} = -g_m R_F (R_D \parallel R_F)$$

$$-g_m (R_D \parallel R_F)$$

5

b



put $R_L \Rightarrow s.c$

$$V_f = 0$$

$\therefore$ voltage feedback

shunt in o/p

shunt - shunt

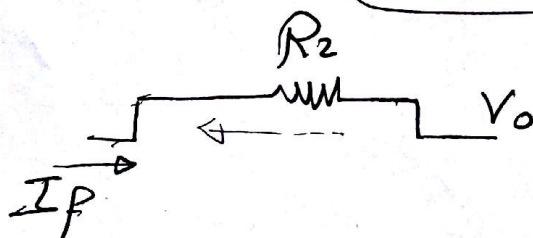
input

من الركن بوضع تيار

ف نفس نقض تيار

الذيل

shunt in i/p

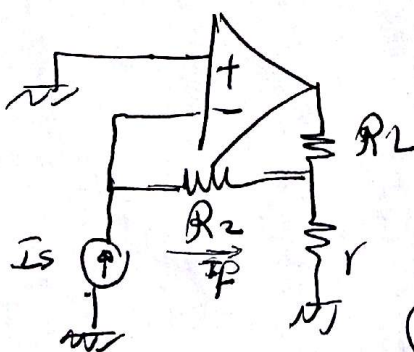


$$\beta = \frac{I_f}{V_o} = -1/R_2$$

$$A_f \approx \frac{1}{\beta} = R_2$$

$$\frac{A}{1+A\beta} \approx \frac{1}{\beta}$$

d



put $R_L o.c$

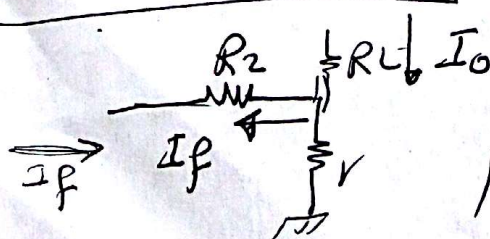
No feedback signal

$\therefore$ Current feedback $\rightarrow$ o/p series

لر جبهه نقض
نقض تيار الفل

i/p shunt

shunt - series



$$I_f = -I_o \times \frac{r}{r+R_2}$$

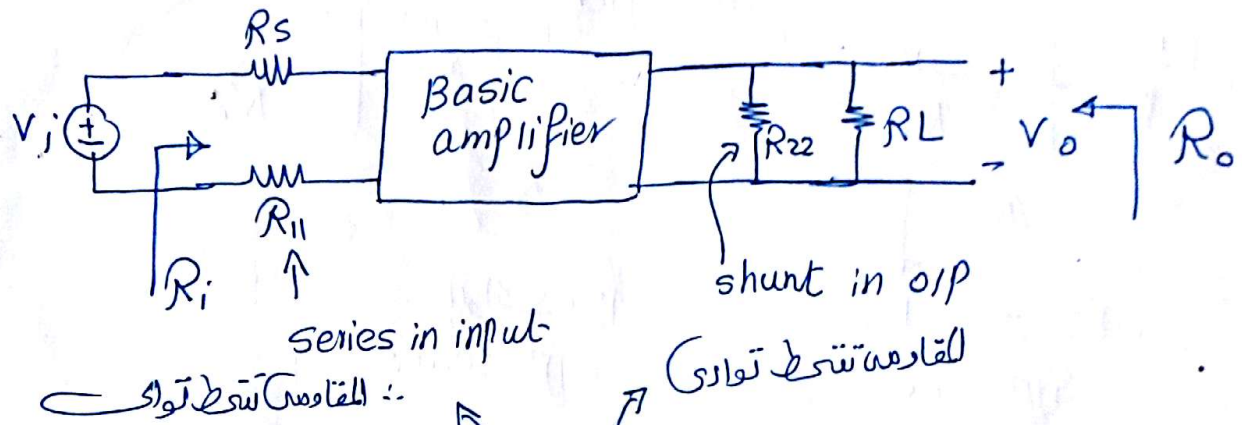
$$\beta = \frac{I_f}{I_o} = -\frac{r}{r+R_2}$$

$$A_f \approx \frac{1}{\beta} = \frac{r+R_2}{r} = 1 + \frac{R_2}{r}$$

Series-shunt Feedback

دو سرکاه
در ورودی
در خروجی
مقاومت

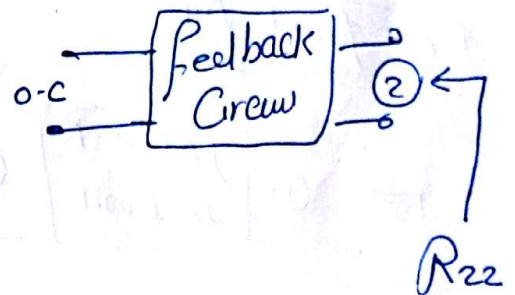
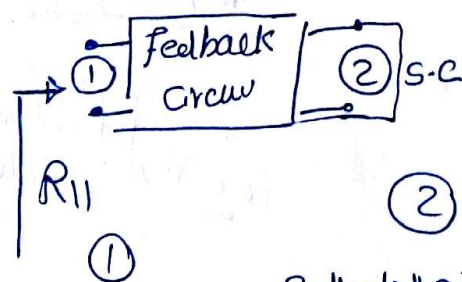
i/p $\Rightarrow$ o/p
 $A \rightarrow$ voltage gain $A_v = \frac{V_o}{V_i}$



الاین دول نسبت وجوده
Feedback circuit

* To find R_{11}

* To find R_{22}



دول ال feedback
amplifier ال خروج ال feedback
خروج ال feedback
amplifier ال

* To find β

$$\beta = \frac{V_f}{V_o}$$

o/p amplifier
i/p feedback

shunt

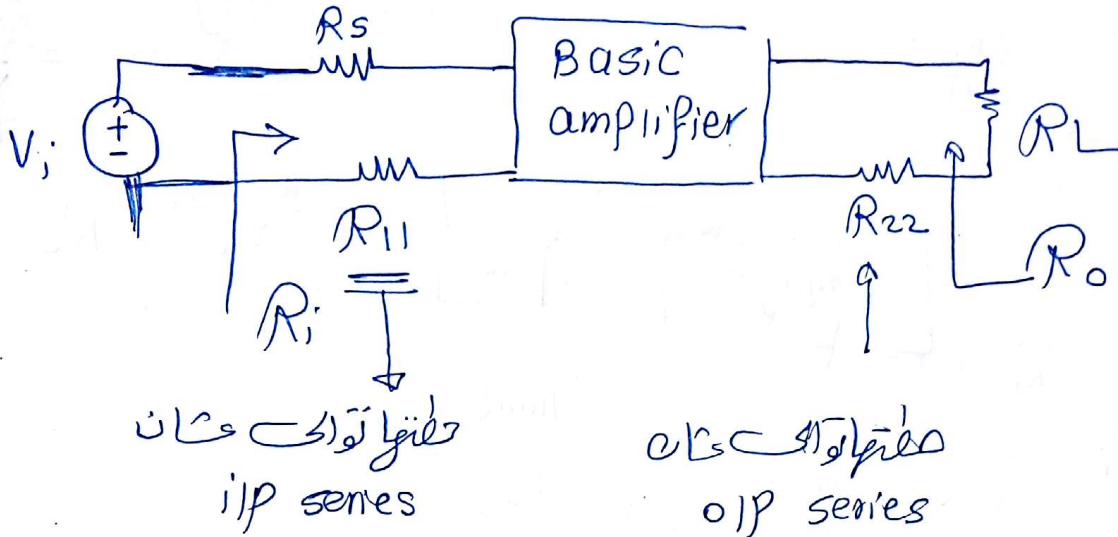


shunt

Series-Series Feedback

↓
دومنه
فان اخل

↓
دومنه
فان اخل



* $\rightarrow$

input

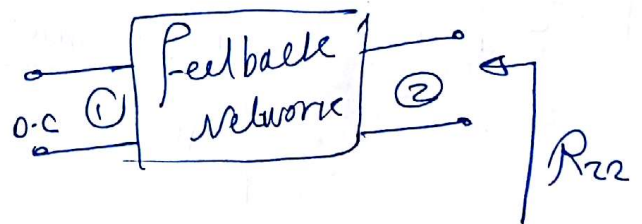
output

$$A \equiv \frac{I_o}{V_i} = \text{Transconductance}$$

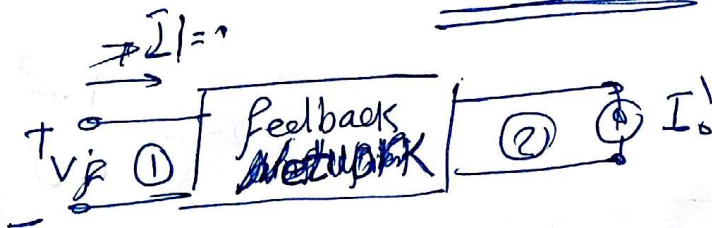
* To find R_{f1}



* To find R_{f2}



* To find β



$$\beta = \frac{V_F}{I_o}$$

* in Series-shunt

of A circuit

R_s $\left\{ \begin{array}{l} R_i \& R_o \rightarrow \text{input \& output impedance} \\ R_{if} \& R_{of} \rightarrow \text{" " " of feedback amplifier including } R_L \& R_s \end{array} \right.$

The actual input and output impedance of feedback amplifier excluding $R_L \& R_s$

$$R_{in} = R_{if} - R_s$$

$$R_{out} = \frac{1}{\frac{1}{R_{of}} - \frac{1}{R_L}}$$

* in series-series

$$R_{in} = R_{if} - R_s$$

$$R_{out} = R_{of} - R_L$$

[7] Series-series feedback amplifier employs a transconductance $G_m = 100 \text{ mV/A}$ & i/p Resistance of $10 \text{ K}\Omega$

• feedback network $\rightarrow \beta = 0.1 \text{ V/mA}$ and i/p resistance " with port 1 open circuit $= 100 \text{ K}\Omega$

$R_{\text{signal source}} = 10 \text{ K}\Omega$ $R_L = 10 \text{ K}\Omega$ $R_{22} = 10 \text{ K}\Omega$ R_{11}

Find A_f & R_{in} & R_{out}

7 series-series feedback employs a trans conductance

- $G_m = 100 \text{ mA/V}$ i/p R of $10 \text{ k}\Omega$
o/p R of $10 \text{ k}\Omega$

- feedback network $\rightarrow \beta = 0.1 \text{ V/mA}$
i/p R " with port 1 open circuit $= 10 \text{ k}\Omega$
i/p R " " " " " " " " $= 10 \text{ k}\Omega$

$$R_s = 10 \text{ k}\Omega$$

$$R_L = 10 \text{ k}\Omega$$

Find A_f & R_{in} & R_{out}

Solution

$$A_f = \frac{A}{1 + A\beta}$$

$$R_{in} = R_{if} - R_s \quad \#$$

series

$$R_{if} = R_i (1 + A\beta)$$

$$R_i = R_s + R_{iamp} + R_{ii}$$

$$R_{out} = R_{of} - R_L \quad \#$$

series

$$R_{of} = R_o (1 + A\beta)$$

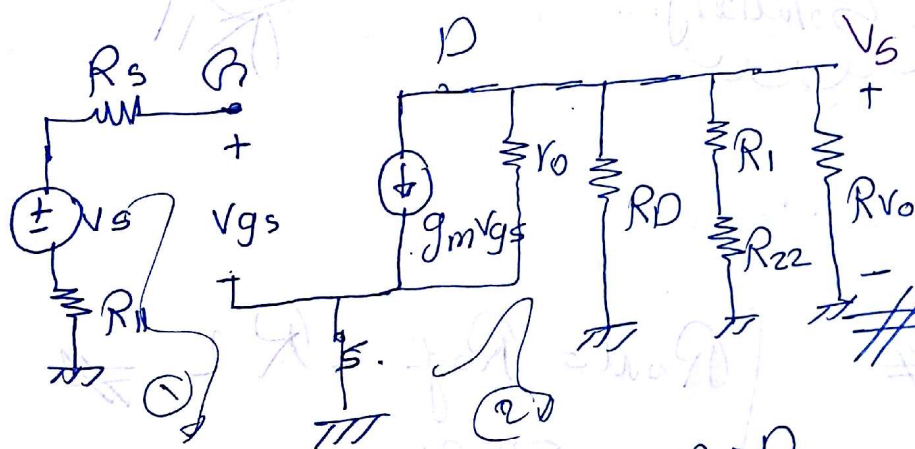
$$R_o = R_L + R_{oamp} + R_{22}$$

- identify F-B type
- Draw equivalent Circuit of (amplifier + feedback)
- expression and calculate $A_v, \beta, A_f, R_{if}, R_o$

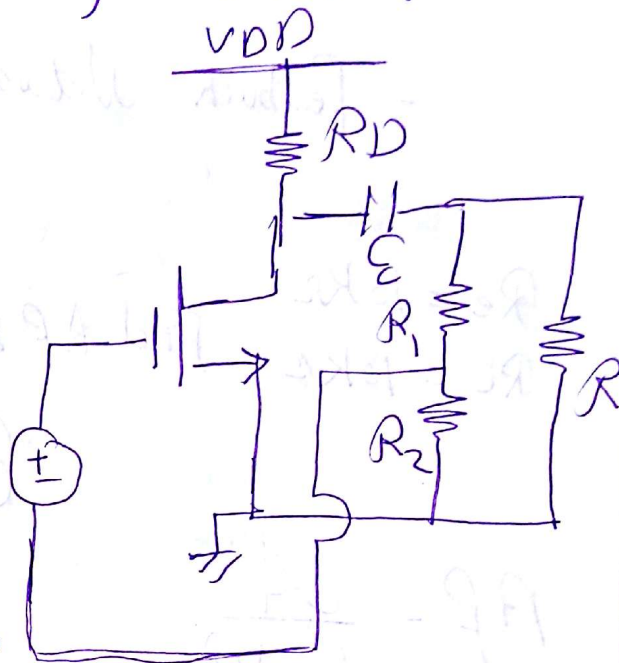
$$R_L = R_S = 10k\Omega$$

$$I_m = 4mA/V \quad V_0 = 100\Omega$$

$$R_1 = 20k\Omega \quad R_2 = 20k\Omega$$



if $P \rightarrow$ Gate
Common-source
o/p $\rightarrow D$



Series-shunt
i/p o/p

Note

$$A_v = \text{voltage gain} = -g_m R_{\text{Drain}}$$

- at R.U.L ①

$$V_o = -(g_m V_{gs}) [R_D \parallel (R_1 + R_{22}) \parallel R \parallel V_0]$$

- at R.U.L ②

$$V_{in} = +V_{gs}$$

$$A_v = \frac{V_o}{V_i} = \frac{-g_m V_{gs} [R_D \parallel (R_1 + R_{22}) \parallel R \parallel V_0]}{V_{gs}}$$

$$= -g_m [R_D \parallel (R_1 + R_{22}) \parallel R \parallel V_0]$$

Mosfet

• with channel length modulation ($\lambda \neq 0$)

$$V_o \rightarrow \infty$$

• without channel length modulation

$$(\lambda = 0)$$

$$V_o \rightarrow \infty$$

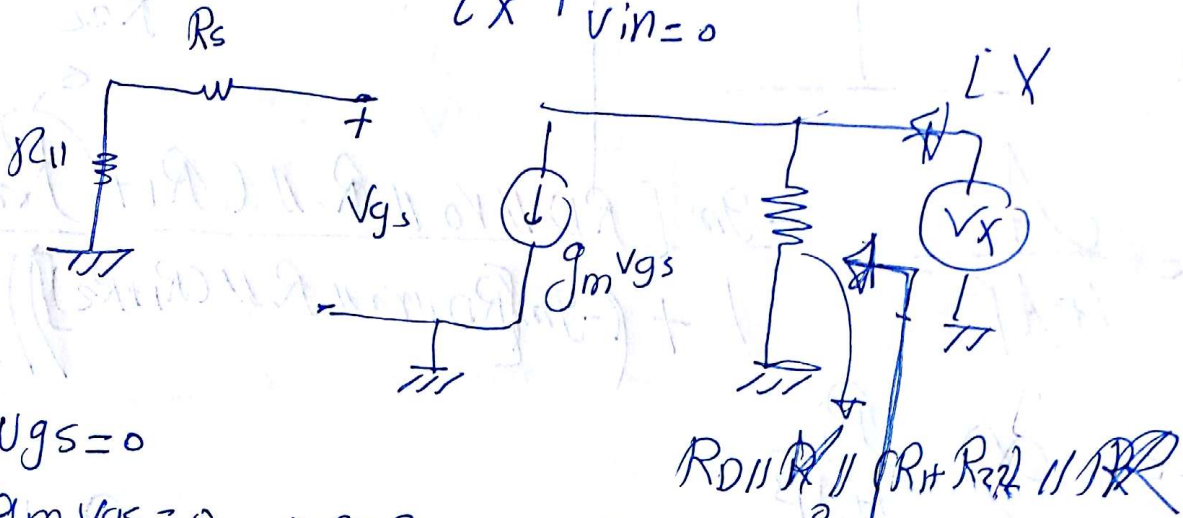
BJT

With early effect $V_A \neq \infty$

without " " $V_A \rightarrow \infty$

$$R_i = R_{i1} + R_s + \infty = \infty \quad \#$$

$$R_o \rightarrow R_o = \frac{V_x}{I_x} \quad | \quad v_{in} = 0$$



$$v_{gs} = 0$$

$$g_m v_{gs} = 0 \rightarrow 0-C$$

$$R_o = R_D \parallel R \parallel (R_1 + R_2) \parallel R$$

feedback سلسله وار

$$A_f = \frac{A}{1 + A\beta}$$

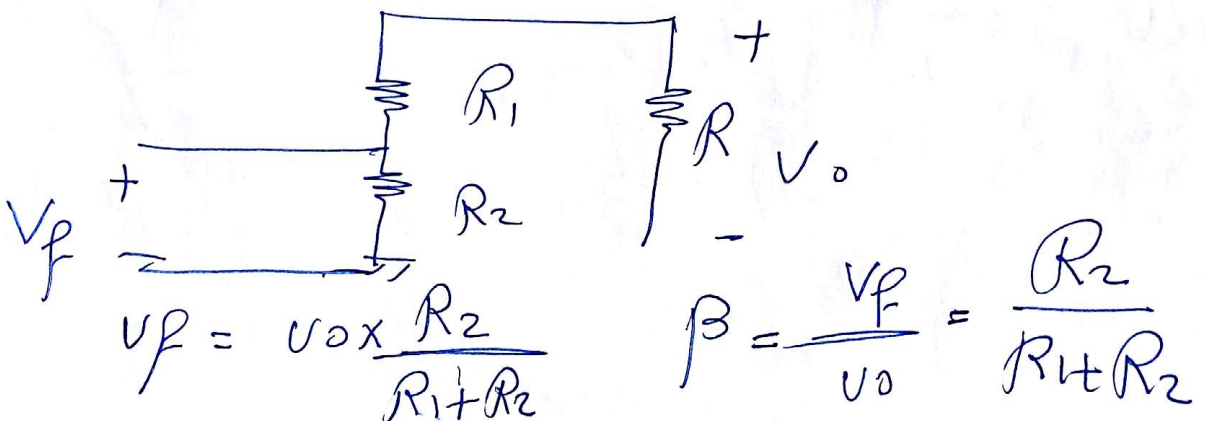
series-shunt

$$R_{if} = R_i / (1 + A\beta)$$

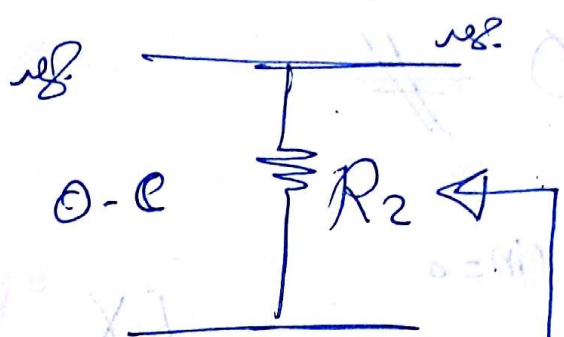
$$R_{of} = \frac{R_o}{1 + A\beta}$$

$\frac{R_i}{1 + A\beta}$ سلسله وار
 $\frac{R_o}{1 + A\beta}$ سلسله وار

$$R_{22} \& R_{11} \& \beta \text{ سلسله وار}$$



R_{22}



(X)

$$R_{22} = R_2$$

$$A_f = \frac{A}{1 + A\beta} = \frac{-g_m [R_D \parallel r_o \parallel R \parallel (R_1 + R_2)]}{1 + (-g_m [R_D \parallel r_o \parallel R \parallel (R_1 + R_2)] \frac{R_2}{R_1 + R_2})}$$

$$R_{if} = \infty \frac{R_i}{1 + A\beta}$$

$$R_{of} = \frac{R_o}{1 + A\beta} = \frac{R_D \parallel r_o \parallel R \parallel (R_1 + R_2)}{1 + (-g_m [R_D \parallel r_o \parallel R \parallel (R_1 + R_2)] \frac{R_2}{R_1 + R_2})}$$

R_{in} & R_{out} is ~~not~~ $\neq$

$$R_{in} = R_{if} - R_s \quad R_{out} = \frac{1}{\frac{1}{R_{of}} - \frac{1}{R_L}}$$

series — shunt



8

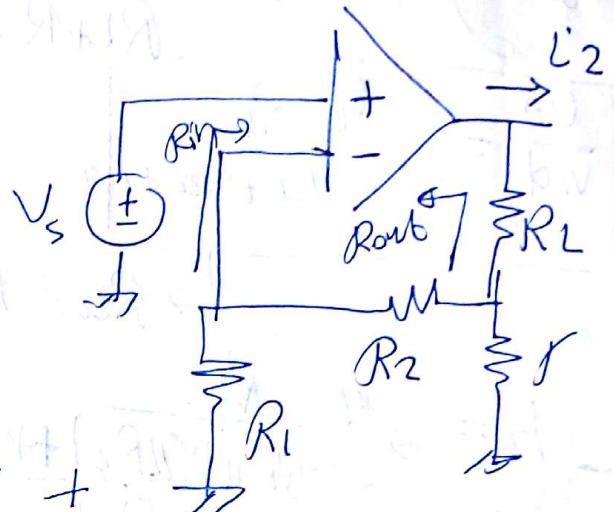
series - Series F.B

voltage Gain μ $R_{id} = 10k$ $V_o = 10$

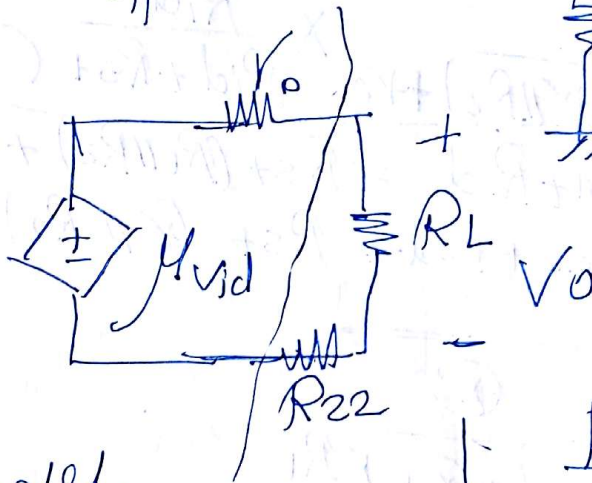
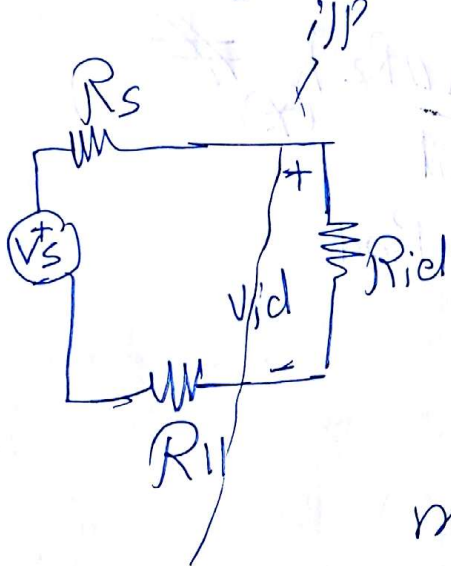
find $A_f = \frac{I_o}{V_s}$ & R_{in} & R_{out}

a) $\mu = 10^5$ V/V $R_1 = 100\Omega$

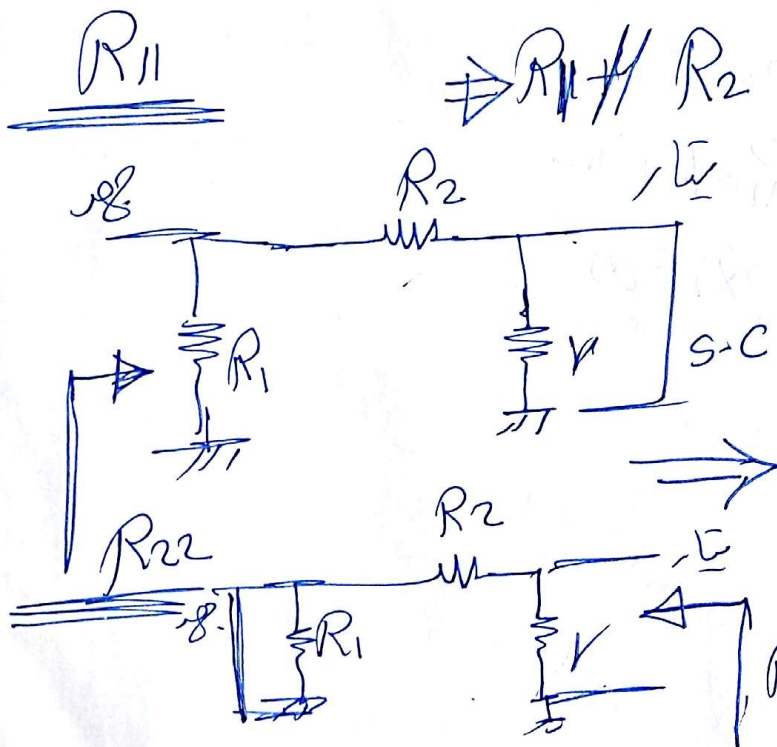
b) $\mu = 10^4$ V/V $R_1 = \infty$



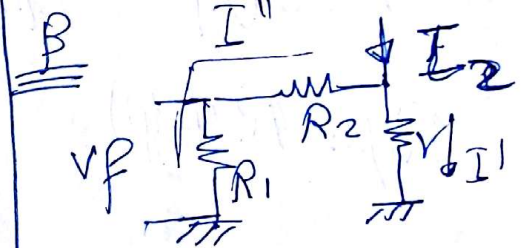
Series - Series



model of opamp



Feedback Analysis



$$V_F = I'' R_1$$

$$I'' = I_2 \times \frac{R}{R + R_1 + R_2}$$

$$V_F = I_2 \times \frac{R}{R + R_1 + R_2} R_1$$

$$\beta = \frac{V_F}{I_2} = \frac{R R_1}{R + R_1 + R_2}$$

$$R_{out} = V/I_2$$

$$A = \frac{V_o}{V_s} = \frac{V_o}{V_{id}} \times \frac{V_{id}}{V_s}$$

(6)

$$V_o = \mu V_{id} \times \frac{R_L}{R_L + R_{22} + r_o}$$

$$\frac{V_o}{V_{id}} = \mu \frac{R_L}{R_L + R_{22} + r_o}$$

$$V_{id} = V_s \frac{R_{id}}{R_{id} + R_s + R_{11}}$$

$$\frac{V_{id}}{V_s} = \frac{R_{id}}{R_{id} + R_s + R_{11}}$$

$\rightarrow R_{11} = R_1 \parallel R_2$

$$\rightarrow R_{22} = r_o \parallel R_2$$

- $A = \mu \frac{R_L}{R_L + (r_o \parallel R_2) + r_o} \times \frac{R_{id}}{R_{id} + R_s + (R_1 \parallel R_2)}$ (*)
- $R_i = R_s + R_{11} + R_{id} = R_s + (R_1 \parallel R_2) + R_{id}$
- $R_o = R_L + R_{22} + R_{od} = R_s + (r_o \parallel R_2) + R_{od}$

$$A_{f\beta} = \frac{A}{1 + A\beta} = \frac{(*)}{1 + (*) \times R_1}$$

$$R_{i\beta} = R_i (1 + A\beta)$$

$$R_{of} = R_o (1 + A\beta)$$

Ex 10.42

a) $\mu = 10^5$ $R_1 = 100 \Omega$

b) $\mu = 10^4$ $R_1 = \infty$